If an event has free food, you should attend—this is something any student knows. So when my undergraduate alma mater invited me back to give a talk (and promised free food), I said yes.

During my time as an undergraduate student at Moravian College in Bethlehem, Pennsylvania, I was involved in the school’s Society of Physics Students chapter. As a senior, I was elected president of SPS and Sigma Pi Sigma. The purpose of my recent return was to give a short, informal lecture on my experiences as a graduate student.

I am currently a graduate student at Temple University and a member of DarkSide (http://darkside.lngs.infn.it/), an international collaboration of universities and labs working together to detect hypothetical particles called weakly interacting massive particles, or WIMPs, that could solve the dark matter problem. When I gave the talk, I had not begun any intense research, so half of my presentation was about adjusting to grad school and half was about doing research and teaching in grad school. I also discussed the work that previous students in my lab accomplished on the WIMP problem.

Dark matter, as I told my undergraduate audience during my talk, is a form of matter that balances some equations of classical mechanics that describe how galaxies rotate.

To explain what is seen in the rotation curves and thus make the equations work out properly, most of the matter in the universe must be dark matter, i.e., stuff that does not emit light. This surprised some of the undergrads in the audience. They wanted clarification on why dark matter was necessary. They wanted to know what dark matter was made of. They wanted to know if there were any alternative theories that would make dark matter unnecessary.

I tried my best to answer their questions, impressed by their level of interest in the subject. The experience reminded me of lectures presented by SPS alumni while I was still in college—including the first time I learned about vortex lattices in superconductors—and bolstered my faith in the future of the physics department at Moravian, which is clearly still inhabited by inquisitive minds.

After I completed my bachelor’s degree at Moravian, I was concerned about how my chapter would fare. Keeping a group of students interested in an academic organization such as SPS can be difficult. Moravian is a small liberal arts college; at times, some of the organizations I was involved in had so few members that you could count them on one hand. It was a fantastic feeling to return to my alma mater and find that things are going just as well—if not better—as when I left them.

Keeping in touch once you’ve graduated can be difficult, as you focus on new responsibilities and relationships. But it’s worth it! It takes minimal effort to send an e-mail to your old SPS advisor asking how things are going. Professors like to know that their students are doing well postgraduation; after publishing a paper in Physical Review D, I made contact with a few of my former professors. It was nice to find out about the current construction going on to improve the natural sciences building at Moravian, to learn about how a recently retired professor was faring, and to keep in touch with the people who had nurtured and strengthened my interest in physics. I’ll be sure to e-mail them again sometime soon, or maybe stop in for a visit when I’m in the area.

Of course, giving colloquia at your alma mater is also a fantastic way to see how the department is doing, catch up with your old professors, and check in on the students. In my experience, most universities welcome alumni speakers, but you just might have to take the first step. Who knows, you may even get some free pizza out of the deal! 🍕
The Win-Win
Connecting undergrads to research in your laboratory

by Jim Gaier, Research Physicist,
NASA Glenn Research Center, Cleveland, OH

I came to the Society of Physics Students and Sigma Pi Sigma late in life. I was, after all, a chemistry major in college. But I also took lots of physics courses as an undergraduate (just one short of a major, really), and my work as a chemist has refused to stay neatly within traditional disciplines. My graduate studies in x-ray crystallography solidly straddled the line between chemistry and physics. To make matters worse, my research focused on determining the structures of biological molecules. After graduate school, NASA hired me as a research physicist to do chemical synthesis and characterization of intercalated graphite fibers. I then joined the chemistry faculty of Manchester College (now Manchester University) in North Manchester, Indiana. One spring soon after, I was invited to join Sigma Pi Sigma. This is when I started my relationship with SPS—late in life, as I mentioned earlier.

After accepting the position at Manchester, I continued to straddle lines by recruiting students from both the chemistry and physics departments to work with me on my research. One of the disadvantages of being a student at a small school such as Manchester is that opportunities and resources to try out research, particularly with expensive, state-of-the-art equipment, are often limited. One of the disadvantages of being a professional scientist at NASA is that we are often constrained by the availability of personnel, so utilizing students to help with NASA research seemed to be the perfect win-win. Indeed, it has been.

Nearly 10 years ago, when I left the faculty at Manchester and returned full time to NASA, I saw no reason why my relationships with students and faculty members at Manchester, the best part of my experiences at the university, should have to end. So I and Greg Clark, the Manchester physics department chair, remain in weekly contact, keeping each other apprised of opportunities at both institutions to collaborate. There have been many.

For example, last year students and SPS members Alyssa Loos and Dylan Ford took advantage of Manchester University’s January term, a month-long break from students’ usual coursework, to do research in my lab for course credit. Alyssa set up a new Fourier transform infrared spectrophotometer (FT-IR), and then studied the degradation of white ortho-fabric samples that had covered large battery packs mounted on the International Space Station for nine years. She used not only the new FT-IR, but also a field emission scanning electron microscope (FESEM) equipped with an energy-dispersive x-ray spectrometer (EDS). This work paved the way for NASA and industry partner ILC Dover, based in Frederick, Maryland, to understand the space environment degradation mechanisms for spacesuit fabrics, which will inform the design of the next generation of spacesuits.

Dylan put together an apparatus to measure the diameter of tiny carbon nanotube yarns in situ while they were being tensile tested using a single-slit-like diffraction technique. This was required because, like any yarn, the material weave tightens up as it is pulled, so to determine the intrinsic ultimate tensile strength, the cross-sectional area must be well determined.

Other students, such as Kerry Rogers and Greg Robison, applied to and were accepted into NASA summer internship programs. Paid for their efforts, they leveraged their NASA work by using equipment at both NASA and Manchester. Kerry wrote a software algorithm to statistically sample microscopic locations on spacesuit fabrics in order to determine the amount of simulated lunar dust left on them after exposure and cleaning. He then looked for damage on other scales using not only NASA’s FESEM/EDS, but also Manchester’s atomic force microscope. Greg designed and built an apparatus to measure the electrical and thermal conductivity of carbon fiber epoxy composites in vacuo at NASA, and then characterized their gamma ray shielding ability at Manchester.

Stephen Berkebile worked both at NASA and Manchester, where he designed and built an instrument to map the two-dimensional electrical

“Many of the ideas students bring are obviously crazy and may even violate physical laws, but they also may spark a new insight, or even an innovation.”

RIGHT
Jim Gaier, research physicist at NASA Glenn Research Center, Cleveland, OH. Photo courtesy of NASA.
conductivity of symmetric and asymmetric woven carbon fiber composites. After graduate school, Stephen returned to NASA as a postdoctoral fellow. He measured the tendency of a synthetic volcanic glass that mimics the major component of lunar dust to adhere to metals and plastics found on spacecraft. He also completed a detailed design of a cosmic ray telescope to be used to characterize the effectiveness of new cosmic ray shielding materials for spacecraft. Whether effective cosmic ray shielding materials can be developed may ultimately determine whether human journeys to Mars and the outer planets are feasible.

I believe that research internships, preferably outside of an academic setting, are critical to the development of young scientists. I recall one of my first Manchester interns, after one of those intensely frustrating days that are so common in research, looking up at me and saying, “You really don’t know the answer, do you?” She had been so accustomed in school to wrestling for an answer that the instructor already knew that she had missed the point of science—to develop new knowledge. This was a revelation that completely changed her view of science, and her role in it.

Students also revitalize a workplace’s vitality, which can wane when the same team works on the same projects or slowly evolving projects. Our group at NASA brings in many interns during the summer; some years they nearly double our size. As they arrive you can feel the enthusiasm level rise. This is our most productive time of the year, not only because we have extra hands, but because we have extra minds with new ideas. Many of the ideas students bring are obviously crazy and may even violate physical laws, but they also may spark a new insight, or even an innovation.

In addition to hosting these and many other Manchester students over the past 20 years, I have also been invited back to Manchester to give several seminars to the science students, to deliver a convocation to the entire student body, and, twice, to be the keynote speaker at the year-end SPS banquet. Many of us in our work seldom get out and talk to nonspecialists about what exactly we do and why we do it. Framing our work such that its value can be glimpsed by college freshmen adds perspective, and getting an enthusiastic response affirms that our work is important. I believe that my ongoing involvement with the students and faculty of Manchester University has deepened and enriched their connections to the world of science. I know that our work together has deepened and enriched my life.

LEFT
Gaier (middle) and intern Dylan Ford (left) set up their measurement apparatus on a tensile tester. Photo courtesy of Jim Gaier.

ABOVE
Lunar dust, the object of study for many of Gaier’s interns, is notoriously sticky stuff; it turned astronaut Harrison Schmitt’s space suit gray during the Apollo 17 mission (top) and penetrated the weave of Apollo 12 astronaut Alan Bean’s suit (bottom). Photos courtesy of NASA.
The Cycle of Inspiration

Alum donor pays it forward

by Candice Fazar, Associate Professor of Physics, Roberts Wesleyan College, Rochester, NY

In the spring of 2012, a student in our Society of Physics Students chapter learned about the upcoming Quadrennial Physics Conference in Orlando, Florida, and during one of my lectures, proposed that the chapter attend the meeting. The majority of the students in the chapter had strong interest in going, even if they had to pay some of the costs themselves.

A simple calculation indicated that if everybody attended we were going to need more than $8,000 to cover all the costs. Fortunately, Roberts Wesleyan College (RWC) has a strong alumni network that supports the school and its students. As I considered how to raise the money, I thought of one particularly special alum: Neal Redmond, who graduated from RWC in 1978 and was inducted into the physics honor society the next year as a graduate student at Adelphi University in Garden City, New York. While working first for Lockheed Martin and subsequently for Science Applications International Corporation, Neal remained involved at RWC as a trustee and donor.

When I first met him in 2006, Neal made it a point to let me know that physics at RWC is in his heart. I remember telling him that I would love to be able someday to give back to my alma mater in honor of my professors there, because I was so thankful for what they had given me. He told me that was the very reason he chose to give to RWC. Proud of the legacy left by his physics and engineering professors, Philip M. Ogden and Donald D. Kerlee, Neal created and endowed the Ogden and Kerlee Scholarships for physics and engineering students at RWC. He asked me to contact him if we needed any additional support.

When our SPS chapter started in 2009, we had an enthusiastic group of students and very little money. I funded a few initial get-togethers out of my own pocket so that the students could have pizza to go with their movie nights or Nerf gun wars. We also managed to attend an American Association of Physics Teachers conference in nearby Syracuse that year. Although we did not need much additional funding, Neal generously donated funds to cover lodging.

After that exciting start, though, the group became rather small and relatively inactive for a few years. Despite my repeated prompts, new members were not as interested in doing things as the inaugural group.

But our classroom discussion about the 2012 PhysCon excited them again. I reached out to Neal, and he donated more than $3,000 to cover my travel costs and the conference registration fees for each student. With this overly generous springboard, we were able to fundraise enough money for six students to attend with minimal out-of-pocket expense.

Attending PhysCon was an absolutely amazing experience, as any one of the students would tell you. Two students toured labs at NASA’s Kennedy Space Center. Two other students presented their research. All enjoyed the talks and group events, which gave them a view of the greater community of physics students and a deeper appreciation for how to fit in. The trip breathed new life into the group and birthed within the students a sense of connection to the greater physics community.

Last spring we started a Sigma Pi Sigma chapter to celebrate academic excellence and service, two values of our physics department. We decided that our Sigma Pi Sigma chapter was going to help our city school students in math and physics. None of this would have happened without Neal’s incredible support. We invited him to our inaugural Sigma Pi Sigma ceremony as an honored guest, along with professor Ogden, now retired. The ceremony brought together RWC students and alumni for the first time, and we inducted several alumni who had graduated before our Sigma Pi Sigma chapter was established.

We hope to continue the tradition of holding an induction ceremony and inviting Sigma Pi Sigma alumni to a catered dinner. Maintaining a connection between students and alumni is important, not just to encourage donations. Our students will someday become alumni themselves, and we want them to invest in a cycle of inspiration and encouragement that will continue from generation to generation at RWC.
was inducted into Luther College’s Sigma Pi Sigma chapter as a sophomore in April 1999. At the time I knew very little about the organization, but I knew it was an honor to be inducted. The ceremony was a joint awards ceremony for the physics, math, and computer science departments, and I clearly remember my professors and fellow students dressed up in suits-and-ties, which was very different from their normal attire.

Little did I know that a decade later I would be Luther College’s advisor to Sigma Pi Sigma and SPS, working to promote community among the physics students, encourage SPS chapter members to delve into physics a bit more deeply outside of their classes, and mentor SPS chapter officers. Nowadays, we are much less formal about our Sigma Pi Sigma inductions, and the ceremony is no longer held jointly with other departments. Instead, we often hold our induction ceremonies at an SPS picnic, so the atmosphere is much more lighthearted than at the suit-and-tie ceremony in which I was inducted.

Our SPS has gone on road trips to local universities and to Fermi National Accelerator Laboratory. We watch episodes of The Big Bang Theory together and answer student-posed questions submitted to our “Ask a Physics Major” box. We design yearly physics-themed t-shirts and put on the annual “Haunted Physics Lab” for community members and their kids.

Our longest-running event has been our semiannual SPS Picnic, where physics faculty, staff, and students gather at a local park to grill and play games. It’s a fun event for students to geek out and spend time together.

Community building is my favorite aspect of SPS and the Luther College Physics Department as a whole, a small department currently with five faculty members and 3–12 majors graduating each year. The department and SPS sponsor a number of events, including the semiannual SPS Picnic and the weekly Physics Tea. I love that these times allow students and faculty to just hang out together, eat donuts, drink coffee, and talk about anything from recent physics news to the latest viral video.

In our department the physics faculty members take turns as SPS and Sigma Pi Sigma advisor, and I’ve been happy to serve for the past 5 years. I am very proud of my students, and I hope that they feel it is a privilege to be a part of SPS and Sigma Pi Sigma, just like I did when I was a student. 🧪

**ABOVE**
Erin E. Flater. Photo courtesy of Luther College.

**BELOW**
The Luther College SPS chapter’s annual “Haunted Physics Lab” thrills community members and their kids. Photo courtesy of Luther College Photo Bureau.